R E P O R T R E S U M E S

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EXPERIMENTATION IN THE ADAPTATION OF THE OVERHEAD PROJECTOR UTILIZING 200 TRANSPARENCIES AND 800 OVERLAYS IN TEACHING ENGINEERING DESCRIPTIVE GEOMETRY CURRICULA.

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AN INVESTIGATION WAS MADE TO DETERMINE WHETHER AN OVERHEAD PROJECTOR AND TRANSPARENCY SET WOULD BE MORE EFFECTIVE AND ACCEPTABLE TO TEACHERS AND STUDENTS THAN TIME-PROVEN CHALKBOARD DRAWINGS IN THE TEACHING OF A DESCRIPTIVE GEOMETRY COURSE. IT WAS FOUND THAT (1) THE LECTURE-DEMONSTRATION PERIOD CAN BE REDUCED TO ALLOW A LONGER SUPERVISED LABORATORY PERIOD, (2) THE STUDENTS' KNOWLEDGE OF FUNDAMENTALS INVOLVED IN PROBLEM SOLUTIONS WAS INCREASED, (3) MORE TIME WAS AVAILABLE DURING THE LECTURE FOR STUDENT QUESTIONS, (4) THE FACULTY PREFERRED TRANSPARENCY DEMONSTRATIONS, AND (5) THERE WAS A NOTICEABLE IMPROVEMENT IN THE FINAL GRADES OF THE TWO TRANSPARENCY-TAUGHT CLASSES VERSUS THE TWO CHALKBOARD-TAUGHT CLASSES. (LP)

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FINAL REPORT

Grant No. 741023.09

U.S. OFFICE OF EDUCATION, DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE

Experimentation in the Adaptation of the Overhead Projector Utilizing 200 Transparencies and 800 Overlays in Teaching Engineering Descriptive Geometry Curricula

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Project Director

This Research Project sponsored under the Provisions of Title VII of the National Defense Education Act of 1958 (PL. 85-864)

June 1, 1959 to August 31, 1960

Submitted by
THE UNIVERSITY OF TEXAS : AUSTIN, TEXAS

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TABLE OF CONTENTS

Chapter		Page
I	Introduction.	1
II	Objectives.	3
III	Procedures.	4
IV	First Semi-annual Report (Portions)	5
V	Second Semi-annual Report (Portions). . . .	8
VI	Statistical Results	
	A. Breakdown of Production Time Schedule	10
	B. Cost Analysis.	20
	C. Covariance analysis of four controlled classes	23
	D. Answers to original five objectives.	35
VII	Recommendations	41
VIII	Appendix	
	A. Copy of questionnaire presented to each student in lead off class. .	44
	B. Copy of questionnaire filled out by each student in four controlled classes.	45
	C. Subjects Covered By Colored Transparencies	46

Chapter I

INTRODUCTION

Engineering Drawing courses are taught by the lecture-demonstration method together with supervised laboratory work. The many drawings made now on the chalkboard must be skillfully constructed, visible to all students and competently explained. Objections to this method are: 1) teacher has his back to the class; 2) figures on the board are too small to be seen by all students; 3) time required for making drawings limits the amount of material covered; 4) most teachers use white chalk, thereby only one color is viewed.

This experiment proposes that approximately 200 drawings with some 800 accompanying overlays required in the lectures for one semester in Descriptive Geometry be made in a professional manner on colored transparencies and projected onto a screen by means of an Overhead Projector. A large image at a short screen distance in a semi-darkened room permits the use of the projector in front of the class, thus enabling the instructor to face and speak directly to those in attendance. This will lead to more effective teaching and handling of larger groups of students.

This new method of presenting the lecture-demonstrations used in teaching Descriptive Geometry, when placed at the disposal of an "average" teacher, will increase the

effectiveness of his classroom lectures and chalkboard demonstrations many fold. This course is taught to all second semester Freshman Engineering students on the following basis: Each instructor lectures one hour, three times a week, covering the basic fundamentals of the problems that will be drawn up in six additional hours of drawing board constructions. His lectures also contain numerous type problems, illustrated on the chalkboard utilizing these basic fundamentals. The effectiveness of the chalkboard demonstrations is materially affected by the skill of the teacher in making them. Therefore by adopting the overhead projector-transparency method of teaching, an "average to good" instructor will be much more capable of becoming an "excellent" teacher in presenting the subject matter in a more interesting, better organized and understandable manner.

Chapter II

OBJECTIVES

Solutions to the following questions will be answered at the conclusion of this experiment:

(1) Can the lecture-demonstration period be reduced so as to enable the students to experience longer supervised laboratory periods?

(2) Will students' knowledge of the fundamentals involved in problem solutions be increased?

(3) Will there be more time during the lecture for the students to ask additional questions?

(4) Shall the faculty prefer to engage in transparency demonstrations in contrast to the time proven chalkboard drawings?

(5) After comparing students in four controlled classes, will there be a noticeable improvement in the final grades of the two Transparency taught classes versus the two Chalkboard taught classes?

Chapter III

PROCEDURES

Approximately 1,000 masters will be drawn, inked and lettered in a professional manner, and will be utilized in developing 200 colored transparencies and 800 overlays. The investigator will use these one semester with two additional instructors viewing the lecture demonstrations. These two instructors will teach four controlled classes totaling 120 students the following semester, two by the Overhead Projector media and two by the Chalkboard method. These classes will be made up at registration and will be organized on a random basis as equally as possible with the teaching method being the only known variable. Daily information on the classes will be tabulated as will grades on each student's 105 drawings, 5 quizzes and 1 final exam. Students' final grades will be statistically compared on a covariance basis of the two teaching methods involved.

Chapter IV

FIRST SEMI-ANNUAL REPORT (Portions)

I. Period covered by this report:

June 1, 1959 to December 31, 1959

OE grant number: 7-1023.09

II. Before this actual study could be made on which method of teaching Descriptive Geometry was the most outstanding, approximately 200 problems had to be conceived, 1000 drawings completed, and colored transparencies made of each.

Work on these problems was started even before final approval of funds was granted. However, this advance start did not solve the problem of completing the numerous drawings by September 15th. This was the original completion date because of the start of the school year. The original plan was for the director to work 40 hours per week and a research assistant to work 20 hours per week for three summer months on these drawings. As the project developed, the director spent a large share of his time on administrative duties, procurement of supplies and materials, and figuring out red tape involved in ordering the necessary equipment needed to teach the lead-off class starting September 20th. This problem caused the hiring of a secretary to be delayed approximately two months.

At the start of this semester, there was a month's supply of transparencies completed, assembled and ready for use. Because of this situation and through cooperation of the Dean of Engineering and Drawing Department Chairman, the project director was relieved of one-quarter time on his teaching contract to allow for completing the necessary transparencies. As of December 31, 1959, all original drawings and transparencies had been completed.

These transparencies are being used in a lead-off class this fall semester by the Project Director. It should be noted here at this early stage of the study that two of the five objectives are already very prevalent.

1. There is much more time during the lecture for students to ask additional questions.
2. From the opinions expressed by several of the Drawing Department Faculty, lectures are presented in a more efficient and interesting manner.

At mid-term in this lead-off class a questionnaire was presented to each student. See Appendix A for a copy of the combined results of this questionnaire. It was noted with interest in this first opportunity of the students to express their opinions, the landslide "vote of confidence" in this media.

III. As to the next steps planned in carrying out this project, the four controlled classes will be set up February 4th, using strictly a random selection of 120 students. Instructors A and B have been assigned sections, class time and rooms. Minor corrections in the transparencies are being made and they will be available for these instructors in the two experimental controlled classes.

Submitted by:

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Assistant Professor
of Drawing

Chapter V

SECOND SEMI-ANNUAL REPORT (Portions)

I. Period covered by this report:

January 1, 1960 to June 30, 1960

OE grant number: 741023.09

II. As of January 4, 1960 the lead-off class taught by the project director was in the closing weeks of the first semester in which these transparencies were being utilized. At the conclusion of the fall semester about the only opinion which could be expressed was from the students who liked this media of communication very much and many were verbally interested in the outcome of the pending research analysis.

Enrollment in the College of Engineering was lower than anticipated at the start of the spring semester, consequently we did not attain the original figure of 120 students in the four controlled classes. During the first class meeting of these two sections, the project director outlined this research study, it's plan and it's objectives. A student questionnaire (See Appendix B) was completed by each student and Form A of the Space Relations 30 minute Differential Aptitude Test was administered. These two instruments were used by Instructors A and B and the Project Director in setting up a Vertical rating scale with

the rank of each student in the two sections (8 and 10 o'clock) of the combined controlled classes. After completion of this ranking from top to bottom a distribution into the "transparency" or "blackboard" class was accomplished by purely random casting of the lot. Each class roll was distributed at the beginning of the second sectional meeting and the four controlled classes were "off and running" on as even distribution as could be ascertained. (Considering we were working with human beings.)

As the semester bore on a noticable edge was evident in favor of the transparency taught classes. Students were very complimentary towards the transparencies and gave evidence they hoped this method of teaching would be continued in the Department of Drawing.

III. The next and final steps planned in carrying out this project are the compiling of statistics covering some 10,700 daily drawing grades, 500 quiz grades, 100 final exam grades and 100 final grade averages. After this is all completed, the objectives of this study will be evaluated and incorporated in a final report which will be submitted to your attention early in September.

Submitted by:

Clayton W. Chance
Assistant Professor
of Drawing

Chapter VI

A. PRODUCTION SCHEDULE

In reviewing most current literature on the production of transparencies prior to the beginning of this research study, the writer was unable to locate data which would be helpful in determining a time schedule for the production of a series of transparencies.

Hence, a need for this type of information was realized and a tabulation was maintained of the many steps involved in this research study on the complete production of transparencies.

Following are tabulations and time sequence breakdowns based on an average time limit of the eleven different steps which were followed in this study.

1. Drawings

New drawings were made up covering each problem area of the curriculum. Upon completion of an accurate pencil master, a series of color separation sketches (CSS) were traced freehand off the master drawing. These were used not only to determine the series of color overlay's desired but indicated the exact information needed on each subsequent step of the

overlay pattern and supplied the total number of overlays needed to explain each problem thoroughly.

Average Time Consumed:

Problem Sketch	First Layout	Master	CSS	TOTAL
1/2	1 1/4	1	1	3 3/4

Note: All figures based on hour readings.

Material: Ozalid Tran-econ OE master paper 8½ x 11 or equal.

2. Numbering System

At this point in the production layout a filing system was inaugurated which corresponded with the chapters of the course textbook and workbook. A file number was stamped on three items in a Set: (a) manila file folder, (b) master drawing and (c) color separation sketches (abbreviated CSS). This became the basis of a master filing system for all drawings and transparencies.

Average Time Consumed: ¼ minute per set.

Material: Justrite BN2-6 Numberer or equal

Dixie Letter Folders 223U ½ cut-undercut

3. Typing

At this stage, typing on the master drawing

included all information found on each of the CSS sheets. It was not necessary to back up the master drawing with carbon paper on this operation.

Average Time Consumed: 12 minutes per master.

4. Printing

The original master drawing was used to make as many non-reproducible blueline intermediate prints as one had pages in the stapled color separation sketches. (CSS) It was determined toward the end of the reproduction process that one additional blue line print should have been run off at this time. This could be used in case an error occurred in inking or typing of the other prints or perhaps a further change would warrant its use.

Note: With the file number already stamped on the original master drawing, all the intermediate blue line prints contained the correct file number automatically. This was a necessity.

Average Time Consumed: 6 minutes per transparency

Material: Tecnifax Texray 214T or equal.

5. Inking

Each non-reproducible blue line print was

inked according to the information contained on each of the CSS sheets. A distinct difference in the weight of lines (ie. object lines, hidden lines, and sight lines) was emphasized more than usual.

Average Time Consumed: 11 minutes per blue line drawing.

Materials: Pelikan Drawing ink or equal. Pelikan Graphos Ruling Pen set or equal.

6. Typing

When typing the necessary information on each of the blue line drawings one must use at least a pica size type and back-up the drawings with either a black or orange color carbon paper. This function allows for a good grade of opacity. Orange carbon has less tendancy to smear.

Average Time Consumed: 3 minutes per drawing

Materials: Ozalid Opaque Carbon Paper or equal

7. Checking

This is best accomplished by use of a light table. After checking the blue line drawings against the master drawing and also the color separation sketches, they should be "placed in registery" on a light table. This will reveal any duplications of effort on more

than one overlay and will also show lines passing through letters or words. This is a VITAL check on drawings in this subject matter area of Descriptive Geometry and will allow for a much more professional presentation.

Average Time Consumed: 1 minute per drawing

Upon completion of the preceding steps in the production process, each master file of drawings is complete. The manila file folder contains: (a) Master drawing, (b) Color Separation Sketches, (c) Blue line prints which in essence become known as the Master Blue line drawings.

8. Printing

In this subject area of the curriculum where sight lines are parallel to object lines; reference planes are perpendicular to sight lines and object lines become lines of intersection, registration of the overlays is of a vital concern in the development of the colored viewfoils. Quite a bit of production time was lost at the beginning of this project because of inferior equipment. However, the writer is happy to report this problem has now been overcome and two types of equipment have been utilized on this project. The Tecnislider

device works very good as an attachment on a high speed Ozamatic copying machine or equal. Another method of printing viewfoils which worked out very nicely was the Slidemaster system which utilized the Proto-printer. This latter setup is somewhat slower, but one can print a large volume of viewfoils after some experience. There are several variables (age of viewfoils, age of photoflood bulb, and strength of ammonia) which when coupled with inexperience will certainly aid in the enlargement of the waste file. Wastage of viewfoils on this project amounted to approximately 19% which was lower than was originally anticipated. Spoilage of the non-reproducible blue line paper was somewhat lower -- 10%.

Experience proved the following method of development to be the most productive. Sort out 8 or 10 Master blue line drawings from the manila folders which call for the same color viewfoil. Run this number through with one setting of the timer, then go on to another color and time setting. This allows for more efficient handling of the opened viewfoil packages. Do not allow ammonia fumes to contact open packages of film. Tape them shut after the days production

run is finished or place the viewfoil package in a clear plastic bag. Caution should be stressed in obtaining the exact exposure of the viewfoils. This film is very sensitive and one-quarter of a minute over or under makes a difference in the printed results.

Materials: Ozalid Viewfoil and Projecto Foil or equal
Tecnifax Diazochrome Film or equal
Tecnifax Slidemaster System or equal

Average Time Consumed: 4 minutes per drawing

9. Sorting

This is somewhat of an automatic operation which hardly needs discussion, but it does take time on the production run. One fast way was followed in this study which was to lay out on a long table, all the manila file folders that were involved in the day's run. Sort the viewfoil and Master blue-line drawings onto the proper file folder, making doubly sure they go with the correct Master pencil drawing and CSS inside the folder. This was ticklish because of close identification of some problems. Once everything is returned to the file folder, it is very time consuming to try and locate a missplaced viewfoil.

Average Time Consumed: ½ minute per drawing

10. Assembling

Almost every project will entail somewhat different problems regarding this area, however, the author shall go into some detail describing what was practiced on this project. The ideas presented here will not only enable a reader to augment his own ideas but offer some new thoughts which only experience can supply.

In this project the first "visual" to be attached to the cardboard mount was called the GIVEN INFORMATION and was always in black lines usually on a tinted base viewfoil. Because of the close registration which was required and the total number of problems involved, a Slide-master System was utilized to an advantage.

The cardboard mount was placed upside down on the pins with the visual (given information) next. Tape down two of the four sides only in this position, ommitting one long side (pins) and one short side (staples). Remove this sub-assembly and place right side up on the pins again. If all subsequent overlays are to be hinged from one side, align them one at a time on the pins and attach metallized Mylar hinges. Make doubly sure the 3 hinges are positioned as far on the overlay as possible leaving only

enough room for the staples and attach the hinge with an equal amount both top side and underneath. If this is not adhered to very accurately, after some usuage, the overlays will "sag" out of registery. Most of our transparencies averaged five overlays plus the visual (given information). We placed two staples in each section of hinges. Next apply the two remaining pieces of tape on back side of mount.This will cover up the ends of the staples allowing for much easier filing. Last, apply three small pieces of opaque tape over the registration holes and stamp the file number on the mount. Any titles or lecture cues may be added if desired.

Average Time Consumed: 15 minutes per transparency

Materials: Technifax Slidemaster System
Tape, translucent, ½" matte-surface 3M-810
Techinges, 1½" square Mylar pressure-sensitive
Stapler, Bostitch Model P6
Tape, Chart-Pak, ½" #2512 Silver
Above materials or equal were used.

11. Filing

On this project we started filing the transparencies in a vertical position in sliding file

drawers. After a short while and because of the many overlays per transparency, they all started sagging out of registery. This required rehinging many of the overlays which is a very time consuming operation. Hence, a horizontal storage cabinet was utilized with each slot holding approximately eight transparencies. This has worked out very successfully. Finger marks, grease pencil and dust may be removed from transparencies by rubbing or wiping with a soft lintless cloth.

Average Time Consumed: ¼ minute per transparency

TOTAL TIME CONSUMED

Following is a tabulation by separate operations involved, in the complete production of approximately 150 transparencies developed under this research grant.

1.	Drawings	225	minutes
2.	Numbering System	0½	"
3.	Typing of masters	6	"
4.	Printing of blue line prints	12	"
5.	Inking	66	"
6.	Typing of blue line prints	18	"
7.	Checking	6	"

8.	Printing of viewfoils	24 minutes
9.	Sorting	0½ "
10.	Assembling.	15 "
11.	Filing	0½ "
	TOTAL.	373 minutes

Or 6 hours and 12 minutes per transparency

(Average = 5 overlays and one visual per transparency)

Note: This time schedule is based on notes of each operation maintained during a production line operation. Probably 8 hours would be closer to actual time consumed if a single transparency problem was to be constructed after some experience is gained of each operation.

B. COST ANALYSIS

When this research project was in the planning stage, it was impossible to assertain a cost breakdown on a project that entailed one's own efforts in the developing and printing of his own transparencies. Therefore, a close analysis of material costs was maintained during the study and is broken down as follows:

ITEM	COST PER TRANSPARENCY
Mounts 50 @ $10.00.	$ .20
Diazochrome Film 8½ x 11, 25 sheet package @ $6.20	1.50

ITEM	COST PER TRANSPARENCY
Tracing paper 8½ x 11, 500 sheets @ $2.50.	$ .04
Texray paper 8½ x 11, 100 sheets @ $2.80.	.16
Tape, ½" wide x 40" long translucent 2592" @ $2.21	.03
Hinges, Mylar 1½" square, 200 per package @ $1.50	.11
Staples, Box 5,000 @ $2.70, 6 per transparency.	.01
TOTAL.	$ 2.05

This is an approximate (material cost only) figure for a transparency which contains 5 overlays and 1 visual.

Add to this for miscellaneous supplies:

erasers, pencils, black lead and colored leads, Ink @ .35 bottle, #4 Photoflood bulb, maximum life 10 hours @ $1.60, ammonia @ $1.25 per gallon.

Operational Costs

These transparencies which were designed and constructed for this research project have been utilized in the teaching of seven classes in Descriptive Geometry over the past school

year 1959-60. No expense whatsoever has been involved in the maintance of the transparencies themselves. However, listed below is a break-down on the Transpaque Junior Projector bulb usuage.

Started using projector September 14th.

Fall Semester	Spring Semester
Two classes - First Bulb burnt out on December 17th.	Five classes - 2nd bulb burnt out on February 8th, 3rd bulb burnt out on March 16th, 4th bulb burnt out on April 27th.

Last day projector was used - May 17th, 5th bulb still in use.

From this record, one may come up with a fair approximation on the number of hours a projector bulb might last. Seventy five (75) clock hours is an average operational figure for a 500 Watt bulb. Care should be exercised in cooling the bulb immediately after use with the twin blowers of the projector for about 4 or 5 minutes. This allows the filament to cool before being moved and therefore this approximate figure of 75 hours can be maintained.

C. COVARIANCE ANALYSIS OF FOUR CONTROLLED CLASSES

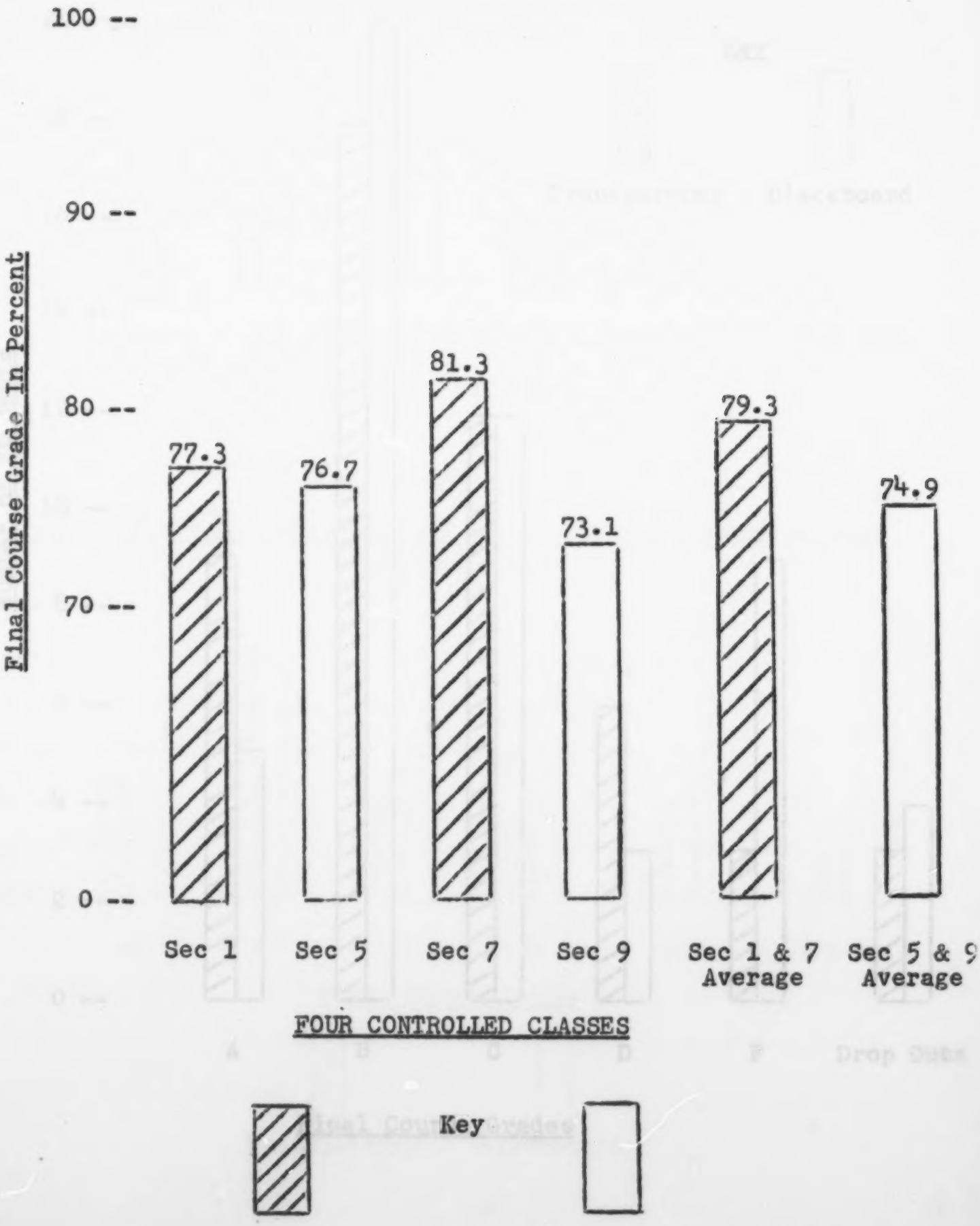
This research study, because of its original conception lends itself nicely to a covariance analysis of the final grade results of the 104 students. This is the main basis for comparing the transparency media with the blackboard method of teaching.

The following four graphs have been compiled to give a visual comparison between these two media.

GRAPH I

COMPARISON BETWEEN TRANSPARENCY AND BLACKBOARD TAUGHT CLASS

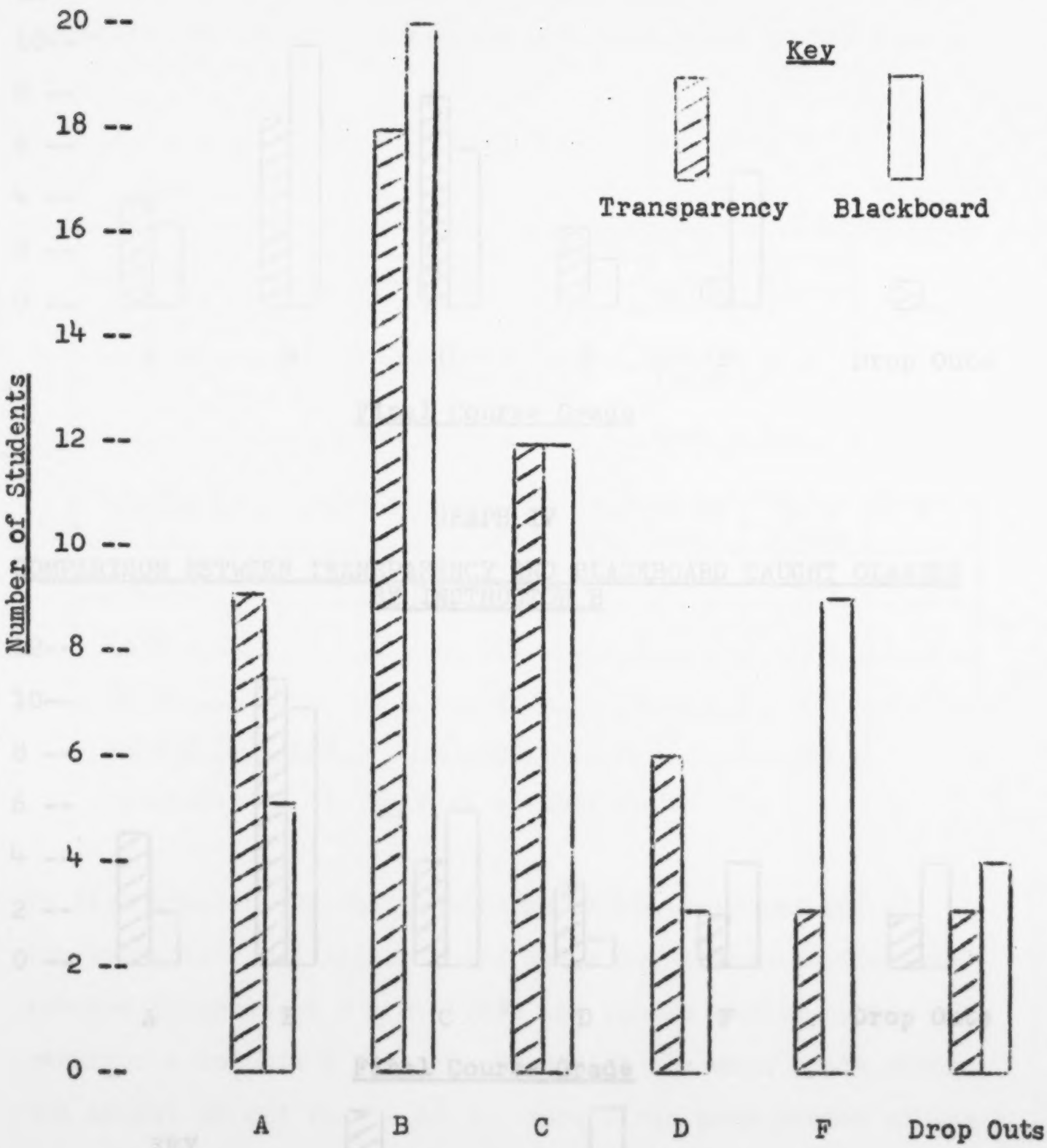
MEAN DEVIATIONS



GRAPH II

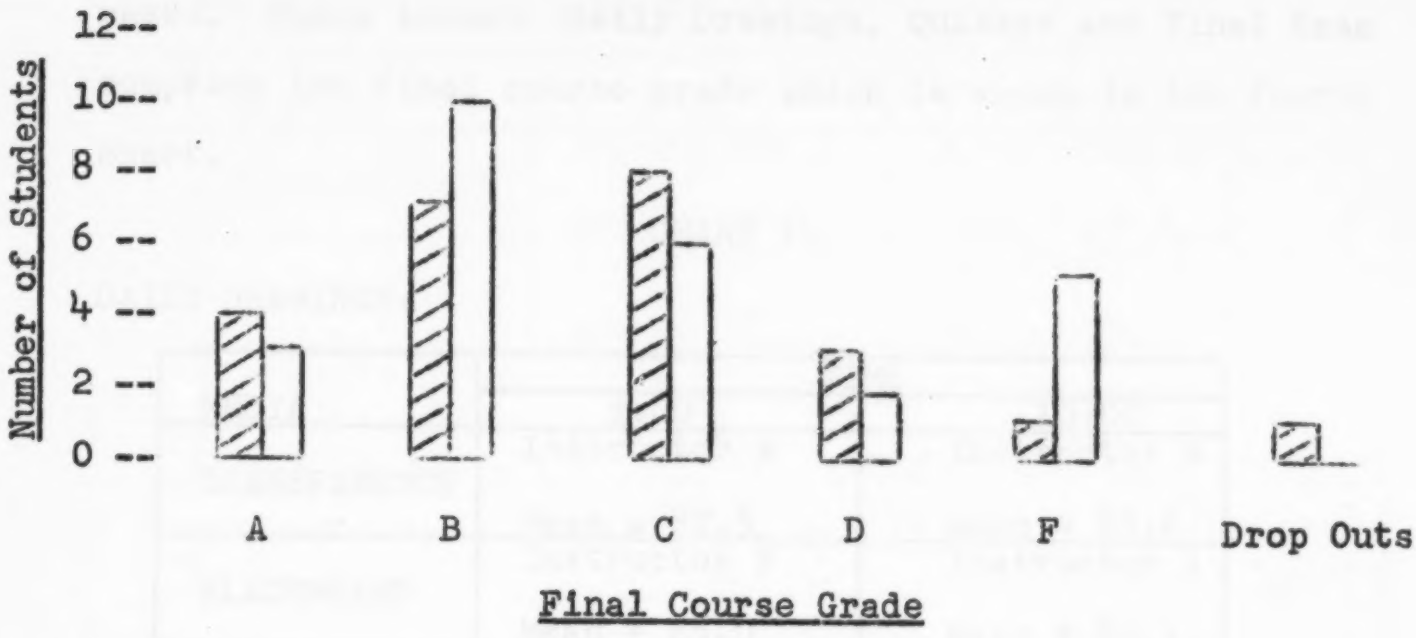
COMPARISON BETWEEN TRANSPARENCY AND BLACKBOARD TAUGHT CLASSES

OF FINAL COURSE GRADES - 104 STUDENTS



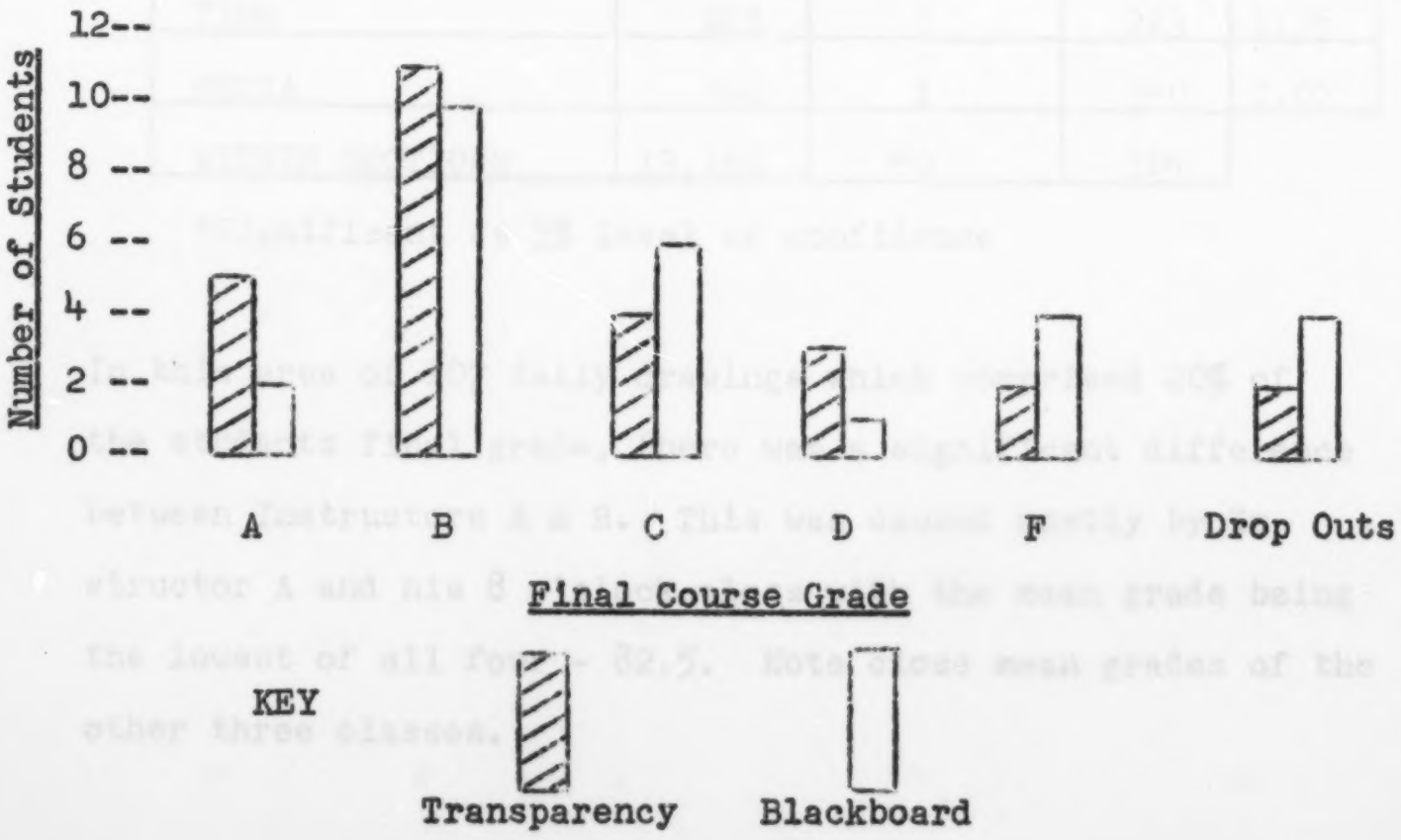
GRAPH III

COMPARISON BETWEEN TRANSPARENCY AND BLACKBOARD TAUGHT CLASSES BY INSTRUCTOR A



GRAPH IV

COMPARISON BETWEEN TRANSPARENCY AND BLACKBOARD TAUGHT CLASSES BY INSTRUCTOR B



Statistical analysis of the three areas of this Descriptive Geometry course are shown in separate charts on the following pages. These three: Daily Drawings, Quizzes and Final Exam comprise the final course grade which is shown in the fourth chart.

CHART 1

DAILY DRAWINGS:

MEDIA	TIME	
	8:00	10:00
TRANSPARENCY	Instructor A Mean = 82.5	Instructor B Mean = 85.6
BLACKBOARD	Instructor B Mean = 85.0	Instructor A Mean = 85.3

SOURCE OF VARIATION	SUM OF SQUARES	DEGREES OF FREEDOM	MEAN SQUARE	F
INSTRUCTORS	849	1	849	5.17*
TIME	223	1	223	1.36
MEDIA	340	1	340	2.07
WITHIN SECTIONS	13,168	80	164	

*Significant at 5% level of confidence

In this area of 107 daily drawings which comprised 20% of the students final grade, there was a significant difference between Instructors A & B. This was caused mostly by Instructor A and his 8 o'clock class with the mean grade being the lowest of all four - 82.5. Note close mean grades of the other three classes.

CHART 2

QUIZZES:

MEDIA	TIME	
	8:00	10:00
TRANSPARENCY	Instructor A Mean = 78.9	Instructor B Mean = 79.4
BLACKBOARD	Instructor B Mean = 77.3	Instructor A Mean = 72.1

SOURCE OF VARIATION	SUM OF SQUARES	DEGREES OF FREEDOM	MEAN SQUARE	F
Instructors	159	1	159	1.07
Time	119	1	119	.80
Media	420	1	420	2.83
Within Sections	11,874	80	148	

Secondly, a comparison of the five quiz grades per student which comprised 50% of the final grade indicates no significant differences statistically between Instructors, times of day or media.

CHART 3

FINAL EXAM:

MEDIA	TIME	
	8:00	10:00
TRANSPARENCY	Instructor A Mean = 71.6	Instructor B Mean = 84.0
BLACKBOARD	Instructor B Mean = 71.3	Instructor A Mean = 70.4

SOURCE OF VARIATION	SUM OF SQUARES	DEGREES OF FREEDOM	MEAN SQUARE	F
Instructors	893	1	159	3.76
Time	708	1	119	2.98
Media	1,027	1	420	4.33*
Within Sections	18.991	80	148	

*Significant at the 5% level of confidence.

The final examination compriced 30% of the students final grade. It was given as a culmination of effort after all daily drawings and quizzes were completed. Here is the first indication of a noticeable difference between the transparency and blackboard media. The transparency group did significantly (at the 5% level) better than the blackboard group. Instructor B supplied a much higher mean grade at 10:00 utilizing the transparency media than at 8:00 with the blackboard.

CHART 4

FINAL GRADE:

MEDIA	TIME	
	8:00	10:00
TRANSPARENCY	Instructor A Mean = 77.4	Instructor B Mean = 81.7
BLACKBOARD	Instructor B Mean = 76.9	Instructor A Mean = 71.8

SOURCE OF VARIATION	SUM OF SQUARES	DEGREES OF FREEDOM	MEAN SQUARE	F
Instructors	452	1	452	3.34
Time	2	1	2	0.14
Media	591	1	591	4.37*
Within Sections	10,809	80	135	

* Significant at the 5% level of confidence.

This area of the course, labled FINAL GRADE, is the most important (from the students viewpoint). Again the transparency group did significantly (at the 5% level of confidence) better than the blackboard group. Both instructors mean grades for the transparency groups were higher than those for the blackboard groups. Instructor A's mean factor of improvement of 5.6 was greater than Instructor B with a 4.8 improvement factor. This could be explained by the fact that Instructor A assisted in the layout of the transparencies and was probably more familiar with the projected content.

CHART 5

SPACE RELATIONS TEST (PRE-TEST)

MEDIA	TIME	
	8:00	10:00
TRANSPARENCY	Instructor A Mean = 79.8	Instructor B Mean = 75.9
BLACKBOARD	Instructor B Mean = 76.9	Instructor A Mean = 80.3

SOURCE OF VARIATION	SUM OF SQUARES	DEGREES OF FREEDOM	MEAN SQUARE	F
Instructors	253	1	253	1.50
Time	1	1	1	.006
Media	14	1	14	.08
Within Sections	11,445	68	168	

Results of the Space Relations Pre-test were used in conjunction with a student questionnaire in setting up the four classes on as even a basis as possible. This method of variance analysis indicates no significant differences. In studying the mean scores for all four classes, it is determined the classes were adequately matched.

CHART 6

SPACE RELATIONS TEXT (POST-TEST)

MEDIA	TIME	
	8:00	10:00
TRANSPARENCY	Instructor A Mean = 88.0	Instructor B Mean = 89.2
BLACKBOARD	Instructor B Mean = 90.0	Instructor A Mean = 91.3

SOURCE OF VARIATION	SUM OF SQUARES	DEGREES OF FREEDOM	MEAN SQUARE	F
Instructors	0	1	0	0
Time	23	1	23	.21
Media	78	1	78	.74
Within Sections	7,147	68	105	

In studying the above results obtained on the Space Relations Post-test, one would conclude that neither media group improved noticeably over the other. Students in all four classes improved their scores equally over the Pre-test.

t TEST

A t TEST was figured on the Space Relations Pre-test and Post-test scores to varify an improvement factor for all four sections. Because of some students not taking the Post-test for various reasons, only those who took both tests were included in the following analysis.

SRT PRE AND POST-TEST TOTALS FOR EACH OF THE FOUR CLASSES

CLASS	NO. OF STUDENTS	PRE-TEST MEAN SCORE	POST-TEST MEAN SCORE	DIFFERENC. MEAN SCOR
8 AM Transparency	18	79.8	88.0	8.2
8 AM Blackboard	19	76.9	90.0	13.1
10 AM Transparency	23	75.9	89.2	13.3
10 AM Blackboard	23	80.3	91.3	11.0
TOTALS	83	312.9	358.5	45.6
AVERAGES		78.2	89.6	11.4

$$t = \frac{\text{(Post-Test Mean) - (Pre-Test Mean)}}{\text{Standard Error of Difference Between Means}} = \frac{11.63}{1.04} = 11.18^{*}$$

*Significant at 1% level of confidence, for degrees of freedom = 8

The result of this t TEST does show a significant improvement in Post-test scores over Pre-test scores. However, the analysis of variance previously reported showed no difference in the improvement factor of one media over the other.

CORRELATION BETWEEN PRE-TEST SCORES AND FINAL GRADE

It was the author's hope that some correlation could be found between scores made on the Space Relations PRE-TEST and the student's FINAL GRADE. If this could be done it would allow for more accurate counseling during the semester of the lowest 1/3 of the students. However, the results of this study did not bear this out. The product-moment coefficients of correlation between these two variables are shown below.

TRANSPARENCY GROUPS	BLACKBOARD GROUPS
r = .07	r = .14

The correlations between PRE-TEST scores and the FINAL GRADES were not significantly different from zero. These low correlations were probably due to the fact that these Freshman Drawing groups at the University of Texas were highly selected groups, as shown below by a comparison with the national norms for 12th grade boys.

	12th Grade Boys	Transparency Group	Blackboard Group
Mean	54.6	76.0	77.9
Standard Deviation	23.6	14.32	13.84

It can be seen from the above figures that the University of Texas students were higher in average ability and less variable as a group than were the 12th grade boys in the

normative sample. In general the students in this course had scores which would place them in the upper half of the 12th grade norm group.

D. ANSWERS TO ORIGINAL FIVE OBJECTIVES

It was originally the responsibility of the project director to set forth answers to the objectives of this research study. These objectives were stated in the original application of this NDEA Grant and are restated in Chapter II of this Final Report. Because it was felt that answers given here would have a stronger significant value if opinions of Instructors A and B were taken into account, they were consulted in the organization of the following answers and agree in essence with their wording.

1. CAN THE LECTURE-DEMONSTRATION PERIOD BE REDUCED SO AS TO ENABLE THE STUDENTS TO EXPERIENCE A LONGER SUPERVISED LABORATORY PERIOD? YES

If the amount of lecture material being viewed by the students could be kept equal for comparison purposes, the transparency media would very definitely provide a shorter lecture period. As the project director visited several lectures of both media, he utilized a stop watch. This revealed an average of 5 minutes per lecture longer duration for the blackboard over the transparency lecture. This additional time spent in lecturing would be even longer if the instructors would have covered an equal

amount of demonstration material on the blackboard that was already prepared in the colored transparencies. Also, it was felt that too much problem construction detail was pointed out by the instructors when using the transparencies. After the instructors become more familiar with the transparencies, overall lecture time in the transparency class could be reduced, hence allowing even more time for a longer supervised laboratory period. An average approximated figure of 15 minutes per 60 minute lecture could be saved by the transparency media over a comparable blackboard lecture which would amount to a 25 percent saving of the students time in a Descriptive Geometry lecture.

2. WILL STUDENTS' KNOWLEDGE OF THE FUNDAMENTALS INVOLVED IN PROBLEM SOLUTIONS BE INCREASED? YES

This objective,with reference to the students' daily work, can probably be answered best by comparing class averages over the daily drawing grades and five quiz grades which were spaced out over a semester of seventeen weeks. The transparency group average was 83.1 percent compared to the blackboard group average of 81.2 percent, a difference of 1.9 in favor of the transparency media. In comparing group averages for the five quiz grade totals the transparency group averaged 78.3 percent to a 75.0 percent for the blackboard a difference of 3.3 percent in favor of the transparency

group. Although neither of these differences is large enough to be statistically significant, both of them are in the same direction--i.e., in favor of the transparency group.

In comparing group averages for the Final Examination grade, the transparency group averaged 76.9 percent in contrast to a 71.2 percent for the blackboard group. This figured a 5.7 percent differential in favor of the transparency group. In comparing group averages for the Final Course grade again the transparency group led the blackboard group 79.3 percent to 74.9 percent. This supplied an average differential figure of 4.4 percent or practically a one-half grade point betterment.

Both of these differences were statistically significant at the .05 level of confidence. The conclusion drawn from these results is that an answer of "yes" can be given to the question originally used in this objective.

3. WILL THERE BE MORE TIME DURING THE LECTURE FOR THE STUDENTS TO ASK ADDITIONAL QUESTIONS? YES

From answers supplied for number one objective, it has been assertained that according to the clock there is more time available if the students wish to ask additional questions and indulge in class discussion for the purpose of a better understanding of the problem solutions. A random selection of various lectures along

with a tabulation of the total number of questions asked in each of the two media groups revealed a surprising fact. Of the total number of questions asked in these lectures, 70 percent were in the transparency group. One idea which the author may express in trying to supply a reason for this fact, is that the transparency media provides an easier way for an instructor to teach this subject. Therefore, psychologically the students feel that the problem solutions are easier to understand, hence, their attentiveness is greater and they realize sooner when a question comes to mind.

4. SHALL THE FACULTY PREFER TO ENGAGE IN TRANSPARENCY DEMONSTRATIONS IN CONTRAST TO THE TIME PROVEN CHALKBOARD DRAWINGS? YES

Before any instructor can express an opinion on this objective, he must actually experience for himself this newer method of teaching by utilizing the overhead projector and colored transparencies. Observation of another instructor using this media is not convincing enough. Because of contrasting differences involved, one should teach more than one class before he starts feeling at ease with the transparency media approach. Also, because of the changes involved in ones' teaching technics, an instructor has to get rid of the philosophy, "You can't teach an old dog new tricks." This project director used the transparency media both semesters of

this past school year and found several technics which could be used after familiarity was gained with the projector, semi-darkened room, transparencies and projection screen. Instructors A and B thoroughly enjoyed the experience of using the transparency media. After observing the final results of this research project, and when additions to the transparency file are completed, instructors A and B join with the project director in an affirmative vote in favor of the transparency method of teaching Engineering Descriptive Geometry.

One additional factor in favor of the transparency media approach to teaching was voiced by most all faculty viewing this research project, that it allowed for a more professional appearance to lecture demonstrations.

5. AFTER COMPARING STUDENTS IN FOUR CONTROLLED CLASSES, WILL THERE BE A NOTICEABLE IMPROVEMENT IN THE FINAL GRADES OF THE TWO TRANSPARENCY-TAUGHT CLASSES VERSUS THE TWO CHALKBOARD-TAUGHT CLASSES? YES

As indicated earlier in this study, the students that participated in this project were ranked by the three instructors on a vertical rating scale and distributed into four equal groupings. These were then cast into a transparency or blackboard group by the toss of a coin. A later review of the Space Relations Pre-Test scores indicated that the four classes started out at the beginning of the semester with as even a

distribution as could be expected. All the known variables were taken into account, namely, a) difference in instructors, b) difference in scheduling time of classes, and c) differenc in teaching methods. At the conclusion of the course, and after final grades were tabulated, a graph was compiled which showed comparisons of the two methods in each of the grade categories. Refer to Graph II on page 25. Notice the differences in the extreme ends of the grade scale. Of the total number of students that made an "A" in the course, 64 percent were in the transparency group. Of the total number of students that made an "F" in the course 75 percent were in the blackboard group. An assumption could also be made after studying these results that if the large number of B students in the blackboard group (20) had been subjected to the transparency media, a goodly number of them might have moved up into the "A" bracket.

CHAPTER VII

RECOMMENDATIONS

If an individual has not experienced the use of an overhead projector, one should become familiar with it and gain experience not by observing, but by actually working with it.

One of the prime advantages as listed in advertising literature is the fact that it can be operated in broad daylight. Experience on this research project shows this somewhat of a false statement. Because of the nature of our Descriptive Geometry problems, the colored lines projected on the screen are washed out unless the room is darkened down approximately 80% of its broad daylight reading. This allows for deep color differentiating and a much more professional presentation.

This projector is designed to allow the lecturer to stand or sit facing his class while at the same instant turning overlays or writing, sketching, or drawing on the acetate roll stretched over the projection light table. It is through this new approach that an instructor still feels that the equipment is an aid and that he retains full control of his student audience regardless of class size.

Transparencies that are prepared previous to the lecture demonstration, allow for two very important features to transpire. First, a much improved presentation in color over a blackboard-white chalk method will increase the students' attentiveness many fold. Secondly, because the students

actually are not learning anything new while the instructor is drawing lines which form the end result, the colored overlays indicate subsequent theoretical steps to the problem solution and save much of the students concentration time.

The Audio-visual medium is based on three psychological bases which are especially important in education. They are sight-mindedness, reinforcement, and repetition. The first of these concerns the fact that most of man's learning is acquired through the sense of vision. Authorities state that approximately 80 percent of our knowledge is acquired through eyesight while less than 15 percent is learned through the sense of hearing. In regards to retention of this knowledge, the following chart* should prove the necessity of not only speaking to the students but allow them to view the problem solutions large enough so that all can "get the lesson".

Senses	3 Hours Retention	3 Days Retention
Ear	70%	10%
Eye	72%	20%
Ear & Eye	85%	65%

* Taken from a taped speech and prepared slides by Lloyd Trump, Director, Commission on Staff Utilization.

The project director has had some eight years teaching experience and has viewed many associations with drawing teachers most of them being in the area of college teaching. Present size of Engineering Drawing classes is based on two reasons -- 1) laboratory facilities have been controlled by the viewing size of a blackboard lecture section; 2) students

of 25 to 30 are enrolled presently because it has been done that way for years and years.

Through experience gained on this research study, because of a larger image controlled by the overhead projector and most important, because of better staff utilization of professional teaching personnel, IT IS RECOMMENDED THAT LECTURE SECTIONS BE ENLARGED TO CONTAIN 75-90 STUDENTS. This would not alter the present philosophy that a large share of teaching of this basic engineering subject is accomplished <u>after</u> the formal lecture in smaller laboratories.

Lastly, we would like to list here the most outstanding advantages of this media of communication as experienced by this research project. The transparency-overhead projector media is better than the blackboard-white chalk method because:

<u>ADVANTAGES</u>:

1. Larger viewing image-more professional presentation.
2. Addition of 6 colors.
3. Improves student attentiveness
4. Allows more time for students to ask additional questions.
5. Review fundamental steps to problem solutions by turning overlays easily.

APPENDIX A

QUESTIONNAIRE FOR DESCRIPTIVE GEOMETRY CLASSES

Class Sections 1 & 7 Date April 1, 1960 Professors A & B

1. Do you like the manner in which lectures are presented utilizing the transparencies and overhead projector?

   19 - 22 (Yes) 0 - 0 (No)

2. Does the addition of color aid you in visualizing the problem more clearly? 18 - 22 (Yes) 1 - 0 (No)

3. When we use color overlays which indicate the fundamental steps to the solution of a problem do you feel this aids you in remembering the solution longer than if it were presented without color? 12 - 18 (Yes) 7 - 4 (No)

4. Do you feel that the problems projected to a larger image allows you to understand the solution better than when you see it on the blackboard on a smaller scale?

   18 - 22 (Yes) 1 --0 (No)

5. In relation to the speed in which a daily lecture is covered using the overhead projector, would you suggest it be: slowed down 3 - 2 speeded up 3 - 3 remain same 13 - 17

6. Do you object to the semi-darkened room every period for the presentation of the lecture? 0 - 0 (Yes) 19 - 22 (No)

7. If you had the opportunity to recommend to a fellow student a blackboard chalk taught class or a transparency overhead projector taught class, which would you suggest?

   1 - 0 (blackboard) 18 - 22 (overhead projector)

APPENDIX B
DESCRIPTIVE GEOMETRY CLASS
QUESTIONNAIRE

(Please Print Neatly)

Name_____Age_____
(Last Name) (First) (Middle)

Austin Address_____Phone No._____

High School Graduated from_____Location_____

Rank in H.S.Graduating Class (Example: 5th out of 175)_____

out of_____OR_____

Quarter of H.S.Graduating Class (Circle one) 1 2 3 4. Year of H.S.Graduation: 19____.

List Past Work Experience - Part-time or Full-time: (Including summer vacations)_____

_____

List Drawing Courses taken in High School

Course_____ Grade_____

_____ _____

Did you take Engineering Drawing 301 at U.T.?____ Grade____

If not at U. T., where_____

If presently engaged in outside work, indicate:

Type of work_____ Number of hours per week?____

Are you aware of any degree of color blindness?_____

DO NOT WRITE BELOW THIS LINE

S R T Score: Final Course Grade____

(Original Ranking Based on 100 Points)

____ ____ ____
C H L

APPENDIX C
SUBJECTS COVERED BY COLORED TRANSPARENCIES

INTRODUCTION:
- 101 General Instructions
- 101-1 Orthographic Dimensions
- 101-2 Three Principles of Orthographic Projection

PRINCIPAL VIEWS
- 201 Positions of a Plane
- 201-1 Positions of a Plane--The Three Principal Views
- 202 Directions of a Line
- 202-1 Point on Oblique Line
- 202-2 Points on a Profile Line
- 203 Which Lines Intersect?
- 205 Determination of Visibility--Oblique Rods
- 206 Determination of Visibility--Bent Quadrilateral

AUXILIARY VIEWS
- 300 Auxiliary Views
- 300-1 Auxiliary Views
- 300-2 Auxiliary Views
- 301 Auxiliary Elevations
- 302 Auxiliary Elevations
- 303 Right and Left Auxiliary Views
- 304 Right and Left Auxiliary Views
- 305 Front and Rear Auxiliary Views
- 306 Front and Rear Auxiliary Views
- 307 Auxiliary Elevations--Locus Plane
- 308 Auxiliary Elevations--Locus Plane
- 309 Left Auxiliary Views--Locus Plane
- 310 Front Auxiliary Views--Locus Plane
- 311 Rear Auxiliary Views--Locus Plane

OBLIQUE VIEWS
- 401 Normal View of a Line
- 401-1 Normal Views of Lines and Angles with the Floor
- 402 Angles Between a Line and Principal Planes
- 402-1 Normal Views of Lines and Angles with Horizontal Planes
- 402-2 Normal View of Braces and Angles with the Floor
- 402-3 Normal View of Lines and Angles with Principal Planes
- 403 Parallel Lines
- 403-1 Parallel Lines--Parallelepiped
- 404 Perpendicular Lines--One Horizontal
- 404-1 Perpendicular Lines--One Frontal
- 404-2 Perpendicular Lines--One Profile
- 404-3 Perpendicular Lines--One Oblique
- 405 Perpendicular Lines
- 405-1 Perpendicular Lines--Right Prism
- 406 Oblique Views for which Direction of Sight is Specified
- 407 Oblique Views for which Direction of Sight is Specified

408 Object in Oblique Position. Hexagonal Base Prism with Two Sides Frontal
409 Object in Oblique Position--Square Base Pyramid with Two Sides Frontal
410 Object in Oblique Position. Pictorial--Profile Line
411 Objects in Oblique Position. (Explanatory)
411-1 Objects in Oblique Position--Locus Plane
411-2 Objects in Oblique Position--Locus Line
412 Object in Oblique Position--Locus Plane

LINE AND PLANE PROBLEMS

500 Vizualization of Plane
501 Strike and Dip of a Plane (Pictorial)
501-1 Strike and Dip of a Plane
502 Lines in a Plane
503 Points in a Plane
504 Angles a Plane Makes with Principal Planes
506 Edge and Normal Views of a Plane
507 Angle between Two Lines
509 Intersection of a Line and a Plane
510 Intersection of a Line and a Plane
511 Intersection of a Plane and a Pyramid
511-1 Intersection of a Plane and a Pyramid
512 Line Perpendicular to a Plane
513 Object Having Its Base in an Oblique Plane
514 Plane Perpendicular to a Line
514-1 Plane Perpendicular to a Line (Pictorial)
515 Plane Perpendicular to a Plane
516 Plane Perpendicular to Two Planes
517 A Line Parallel to a Plane
518 A Plane Parallel to a Line
519 A Plane Parallel to a Plane
520 True Length of a Line--Angle It Makes with Horizontal Plane
521 True Length of a Line--Angle It Makes with Frontal Plane
521-1 Angle Sun Ray Makes with Frontal Window
521-2 True Length of a Line--Angle it Makes with a Profile Plane
522 Location of Points on a Profile Line (Three Methods)
522-1 Location of Points on Surface of Cone
523 True Shape of a Plane by Revolution
524 Distance from a Point to a Line
525 Shortest Distance between Two Lines
526 Angle between Line and a Plane--Complementary Angle Method
527 Angle between Line and a Plane--(Direct Method)
528 Angle between Line and Plane (Revolution Method)
529 Intersection of Planes (Piercing Point Method)
530 Intersection of Planes---Pictorial (Cutting Plane Method

530-1 Intersection of Planes (Cutting Plane Method)
531 The Angle between Two Planes
532 A Line Making Given Angle with Two Planes
533 A Plane Making Given Angles with Principal Planes
534 Plane through a Line and at a Given Angle with a Principal Plane

SURFACES AND DEVELOPMENTS
601 Development of a Right Prism
602 Development of an Oblique Prism
603 Development of a Right Pyramid
604 Development of an Oblique Pyramid
605 Development of a Right Cylinder
606 Development of an Oblique Cylinder
607 Development of a Right Cone
608 Development of an Oblique Cone
609 Development of a Hopper
610 Development of a Transition Piece
610-1 Development of a Transition Piece (No Vertex)
610-2 Development of a Conical Connecting Piece (Vertex Given)
611 Layout and Development of a Cylindrical Elbow

SURFACES AND INTERSECTIONS
701 Intersection of Two Prisms--Edge View Method
702 Intersection of Two Pyramids--Piercing Point Method
703 Intersection of Two Right Cylinders
703-1 Intersection of Two Right Cylinders (One Positive--One Negative)
704 Intersection of Cones--Axes Parallel
705 Intersection of Cone and Pyramid. Intersection of Cone and Prism
705-1 Intersection of Cone and Prism (Two Problems)
706 Intersection of a Right Cone and Cylinder (Axes Skew Lines)
706-1 Intersection of Two Oblique Cylinders
707 Intersection of a Sphere and Cone (Cutting Sphere Method.
708 Intersection of Sphere and Right Cylinder (Cutting Cylinder Method)
708-1 Intersection of a Plane and a Sphere
709 Points on a Sphere--Intersection of a Line and Sphere
709-1 Intersection of two Spheres
709-2 Intersection of a Sphere and Cone
710 Intersection of Torus and Two Cylinders--One Positive, One Negative

WARPED SURFACES
801 Hyperbolic Paraboloid
802 Cylindroid
803 Right Conoid
804 Oblique Conoid

805 Right Helicoid-Stairway
806 Oblique Helicoid
807 Warped Cone
808 Cow's Horn
809 Hyperboloid of Revolution

GEOLOGY AND MINING PROBLEMS

900 Contour Maps
900-1 Geology and Mining Definitions
901 Strike and Dip of Vein
901-1 Strike, Dip, Thickness of Vein--Mine Workings
902 Strike and Dip from Two Apparent Dips
902-1 Strike, Dip and Thickness of Vein (Shortest Horizontal Tunnel and Vertical Shaft)
903 Shortest Crosscut on a Given Grade
904 Intersection of Vein and Fault Plane
905 Location of Outcrop
906 Cut and Fill for Level Area
907 Cuts and Fills for a Level Roadbed (Straight)
907-1 Cuts and Fills for a Level Roadbed (Curved)
908 Cut and Fill Contour Lines on Inclined Road (Explanatory.
908-1 Cut and Fill for a Road on a Grade
909 Mine Dumps

ENGINEERING PROBLEMS

1001 Rafters--Jack
1002 Hip Rafters
1003 Timber Framing
1004 Grade Line in a Plane
1004-1 Location of a Road on a Given Grade
1005 Explanatory Vector Diagrams for Concurrent Coplanar Forces
1005-1 Force Diagram for Concurrent Non-Coplanar Forces (Equilibrant)
1006 Forces in a Structure of three Intersecting Non-Coplanar Members